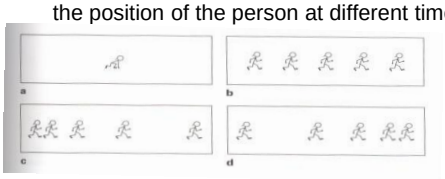
Motion in Two Dimensions

- Position and Displacement
- Speed
- Velocity
- Graphing Position vs. Time

Motion Diagrams

When working motion problems, it is often helpful to draw diagrams showing that motion.

Below are examples of motion diagrams, and the position of the person at different times.



Motion Diagrams & Distance

Terms

Origin - where measurement starts

Position (d) - where an object is located

Scalar - magnitude of a quantity

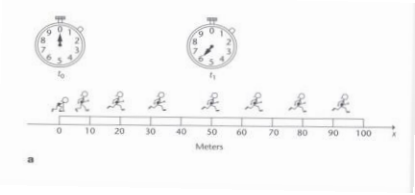
Vector - magnitude and direction of a quantity

Displacement - shows the distance and direction between two positions

Distance (Δd) - length or size of the displacement vector ($d_1 - d_0$)

Identify

In your notes, label the origin, the initial and final positions (d_0 and d_1), displacement vector and the distance (Δd) between the two times



Displacement Vectors

In physics, the movement from the origin can be thought of positive or negative.

What is the difference between a positive displacement and a negative displacement?

Speed and Velocity

Velocity - a vector quantity that tells the ratio of the displacement change to the time change, or how fast an object is going and in what direction.

Speed - The magnitude of the velocity, or how fast an object is moving.

Equation: $\bar{v} = \frac{\Delta d}{\Delta t} = \frac{d_1 - d_o}{t_1 - t_o}$

Types of Speed

Speed is the measure of the rate at which an object moves.

There are 3 types of speed

1) Average speed - taking all your speeds over the whole trip and taking an average
2) Constant Speed - traveling at the same rate for a long period of time.
3) Instantaneous speed - rate at which an object is traveling at a certain moment.

Speed Formulas

Average speed can be calculated using the following formula:

$$v = \frac{\otimes d}{\otimes t}$$

This equation can be rearranged into:

$$d = vt \quad \text{or} \quad d_1 = d_0 + v(\otimes t)$$

Graphing Speed

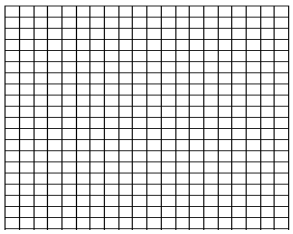
When graphing speed, it is necessary to plot distance data on the y-axis and the time data on the x-axis. Then, when you calculate the slope, which is

$$\text{slope} = \frac{\Delta y}{\Delta x} = \frac{\Delta d}{\Delta t}$$

you are actually calculating the speed of the object, or the distance traveled per unit time.

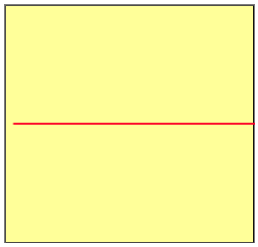
Position vs. time graphs

Δ d (m)	t (s)
0	0.00
25	2.20
50	4.35
75	6.72
100	8.75
125	11.01



Interpreting speed

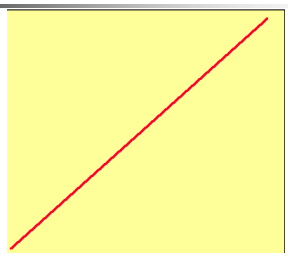
position



Time

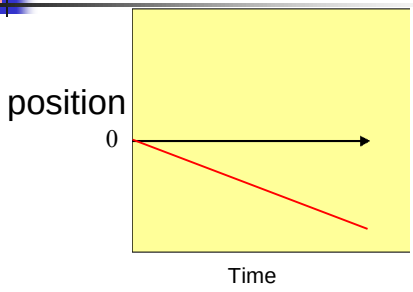
Interpreting speed

position



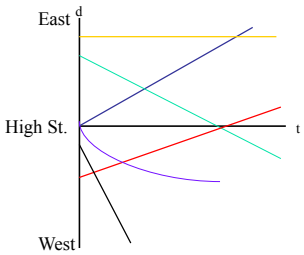
Time

Interpreting speed



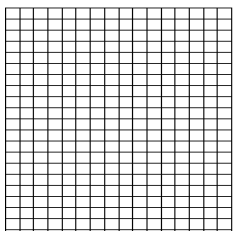
What is the motion?

The diagram at the right represents 6 different pedestrians on the same road. Describe each pedestrian's motion.



Position vs. time graphs

Two motorcycles leave from the same spot at the same time. Bike 1 travels at 50 mi/hr for 1.5 hr, stops for 1.5 hr, then continues on at 60 mi/hr for 4 hr. Bike 2 travels at 45 mi/hr for 6 hr. Draw a position-time graph for the two bikes in this information.



Difficult Problems

- Lizzie decided to race Michael Phelps in the 200 m freestyle last week. Michael swam at a blistering 1.23 m/s, while Lizzie swam at 0.51 m/s. How much of a head start would Michael need to give Lizzie to have tied a race? Give your answer in terms of time and distance.
- Ben is riding his unicycle at 12.3 m/s east, while Cuteo is riding his horse at 16.5 m/s west. If Ben and Cuteo started 357 m apart, where and when would they collide?